Available online at www.sciencedirect.com

ScienceDirect

Procedia Engineering 69 (2014) 897 – 901

Procedia Engineering

www.elsevier.com/locate/procedia

24th DAAAM International Symposium on Intelligent Manufacturing and Automation, 2013

Effect of Heat Load on a Forging Press

Zdenek Chval*

University of West Bohemia, Faculty of Mechanical Engineering, Department of Machine Design, Univerzitni 8, 306 14 Pilsen, Czech Republic

Abstract

Currently, great emphasis is placed on product quality, which results in increased demands on the design of forming machines. Together with the high quality and long-term reliability of forming machines, high energy efficiency of equipment and low cost is also very important. When designing a forging machine, it is necessary to take into account the effects of heat on the construction. It is important to perform an in-depth analysis of the possible influences of temperature on individual parts of the forging press and subsequent effects on durability of the construction and machine accuracy. The article deals with the thermal analysis of a hydraulic forging press.

Keywords: forming machines; hydraulic forging press; heat load; FEM simulation

1. Thermal effects

Nowadays the quality of products is very important and design demands of forging press are always increasing. Quality and competitiveness of products manufactured on a forming machine is influenced by many factors, such as stiffness of the workspace, the strength of the frame, energy balance, etc. Temperature effects on structure is an important design factor, especially in technology operations with a high forming temperature, up to 1200 °C. Heat load factor should be taken into account when designing a new forging press. The aim of this article is to highlight the importance and seriousness of thermal loading on forming machines, and especially to notify producers of forming machines that thermal loading cannot be neglected in machine design but on the contrary it must be given due attention.

* Corresponding author. Tel.: +420 377 63 8213.
E-mail address: zdchval@kks.zcu.cz

doi:10.1016/j.proeng.2014.03.068

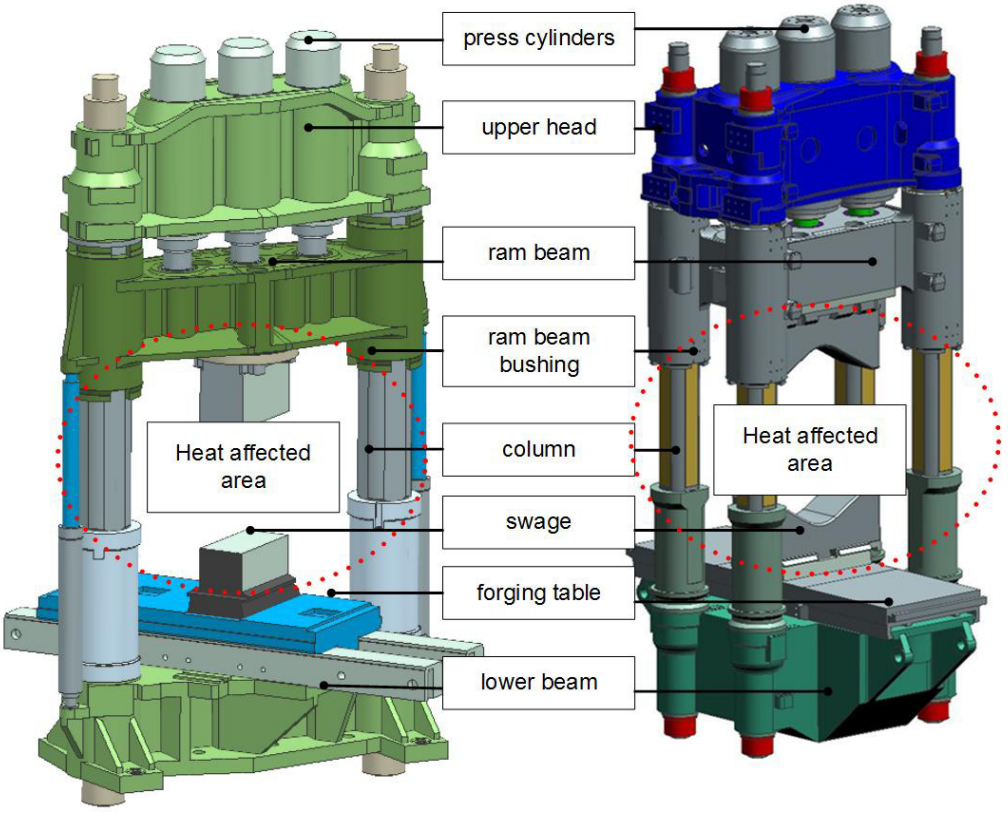

Fig. 1. (a) Hydraulic forging press CKV 40/50 MN with heat affected area, (b) Hydraulic forging press CKV 84/105 MN.

Heat sources that occur on forming machines can be divided into 3 groups:

- Heat from forming material – the subject of this article
- Heat generated in the forming machine (friction between moving members - guiding the moving parts, expansion of the working fluid, friction from clutches and brakes, etc.)
- Heat that is transferred from the surroundings

The working area of the machine is mostly influenced by the heat of the molded piece. This area often has the greatest impact on the accuracy of products. Each type of forming machine is specific, and therefore thermal analysis must be carried out separately for each forming machine. This article is focused on a hydraulic and mechanical forging press.

Heat affected area, see Fig 1a:

- Columns
- Ram beam bushing
- Ram beam with swage
- Forging table

2. Hydraulic forging press CKV 84/105 MN

The first representative to be analyzed was hydraulic forging press CKV 84/104 MN, see Fig. 1b, in 2011 [1, 2, 3, 4]. The aim of the project was to verify the thermal influence of the working area of this machine during the technological process of hot forming, see Fig. 2, to identify critical areas to determine the extent and severity of this interaction and to provide recommendations for further progress in the issue of thermal effects.

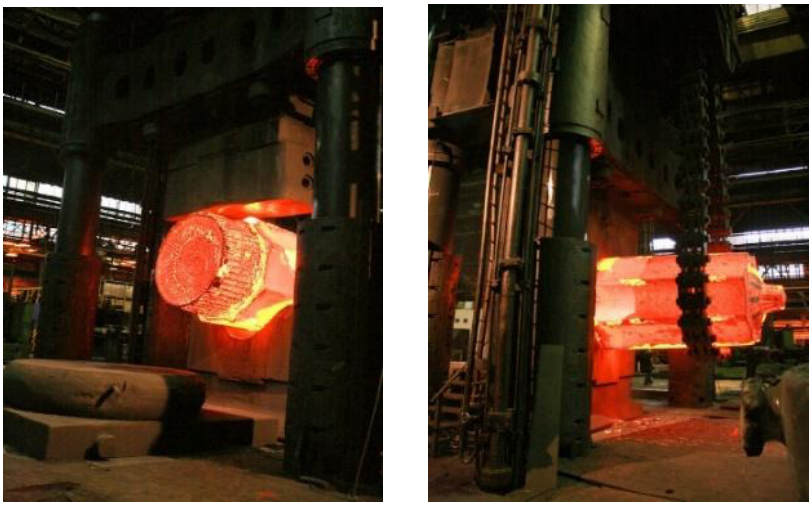

Fig. 2. Hydraulic forging press CKV 84/104 during the forming process.

Temperature measurement and calculation on the hydraulic press CKV 84/105 MN indicated that in this particular case the thermal effect is not relevant. During the calculated period of time there were no significant temperature changes in the construction. The reason was the sufficient time for cooling of the press during technology breaks. Furthermore, the large size of the working space of the press, which does not enable absorption of large amounts of radiated heat into the construction.

From the forging operations through to ensuring the negligibility of thermal effects in a particular hydraulic press, there is a need for thermal analysis on the forging presses. The reason is the experience from practice of the complicated setup of ram clearance due to thermal effects.

After a two-year interval a hydraulic press CKV 40/50 MN was chosen for thermal analysis.

3. Hydraulic forging press CKV 40/50 MN

It is a hydraulic forging press with a top drive, vertical, two columns construction. The actuator is realized by three hydraulic plunger cylinders working at the upper head. Working fluid is an emulsion of water with oil [5, 7].

Press was loaded by, see Fig. 3:

- Temperature of forged piece
  Temperature of forged piece was set to 1200°C as an initial temperature.
- External conditions
  Ambient temperature of the press was set to 20 °C. The airflow around the press was selected as minimum 0.1 mm/s.

Each part of the press was connected by thermal contacts simulating heat conduction or radiation [9, 10].

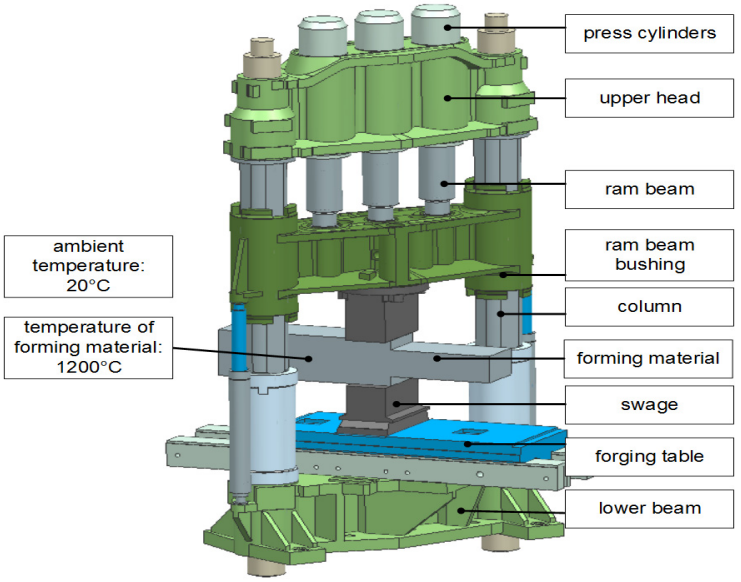

Fig. 3. Hydraulic forging press CKV 40/50 MN boundary conditions of thermal calculation.

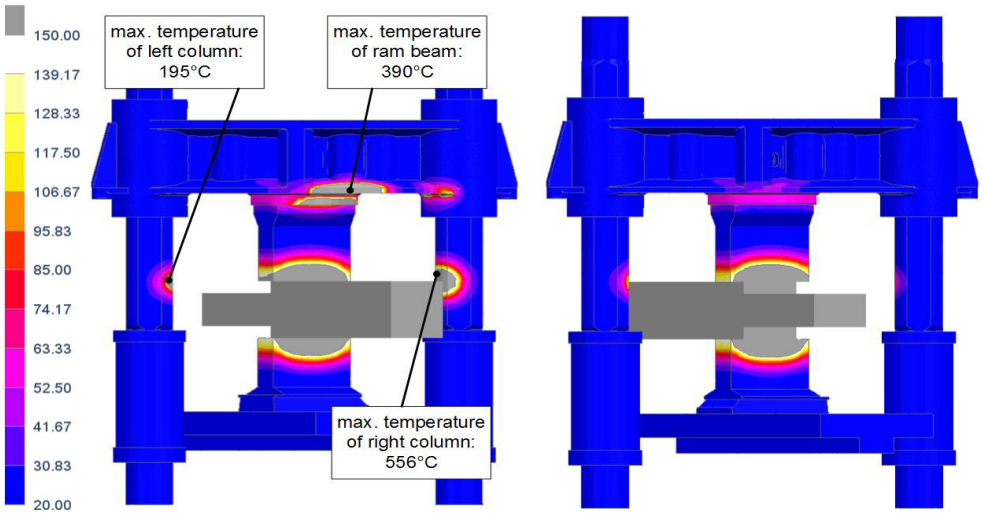

Fig. 4. Results of thermal analysis of the hydraulic forging press CKV 40/50 MN after one hour (°C).

The maximum temperature reached on the column after one hour is 556°C and the maximum temperature difference between the left and the right column is 361 °C, see Fig. 4. The maximum temperature reached on the column after five hours is 559 °C and the maximum temperature difference between the left and the right column is 379 °C, see Fig. 5. Further effects of the heat load do not increase the temperature. There is only a general warming of the structure. The calculation shows that in this case the influence of heat load on the machine cannot be ignored. We can say that the temperature will have a significant impact on defining the clearance of the ram beam bushing.

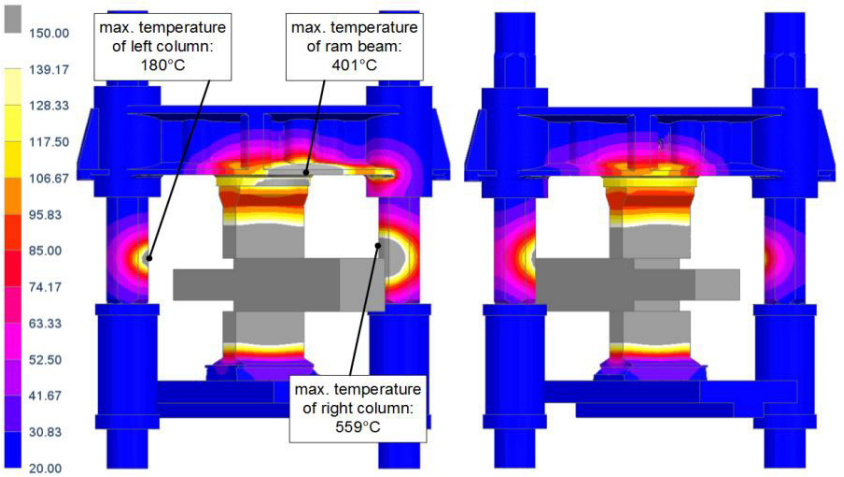

Fig. 5. Results of thermal analysis of the hydraulic forging press CKV 40/50 MN after five hours (°C).

4. Conclusion

The analysis shows that the thermal load of a hydraulic forging press is important and will significantly influence the clearance of the ram beam bushing. It is important to emphasize that the chosen boundary conditions are very unfavourable and the values obtained will probably not be achieved in the operation of the press. It is the assumption that during forging there will be technological breaks when the press can cool down, and also the airflow in the forge will be greater than envisaged.

Future work should focus on refining the boundary conditions so as to allow us to say whether the thermal load on a specific machine and technological conditions are relevant or not.

With regard to the energy balance of the whole technological process, we need to think about how to limit the amount of energy wastefully escaping into heating the components of the machine [6].

Acknowledgements

The article was supported by the motivation system of the University of West Bohemia, part of the postdoctoral programme [8].

References

[1] Z. Chval, J. Stanek, Temperature Effect of Molded Piece to Forming Machine, ISBN 978-80-227-3135-5, Bratislava, 2009.
[2] Z. Chval, Reducing Material Costs and Effect of Heat Load of Forming Machines, Ph.D. Dissertation, University of West Bohemia, 2011.
[3] F. Tikal, M. Duchek, FEM Analyses of the radiation in heating forging furnace, Annals of DAAAM for 2011 & Proceedings of the 22nd International DAAAM Symposium, ISSN 1726-9679, ISBN 978-3-901509-83-4, Vienna, Austria, EU, 2011.
[4] M. Cechura, Z. Chval, Convectional Versus Multiple Operating Press, Kovarenstvi, May 2013/17, 67-70, ISSN 1213-9289, Brno, 2013.
[5] V. Kubec, K. Raz, Two-columns Versus Four-columns Hydraulic Press, Kovarenstvi, May 2013/17, ISSN 1213-9289, Brno, 2013.
[6] M. Cechura, J. Housa, Energy Analysis of Forming Machines and Further Proposals for Decreasing of Energy Consumption, research report, V-11-037, VSCVTT, Prague, 2011.
[7] M. Cechura, J. Smolik, Development Of New And Innovations Of Existing Construction Solutions Of Forming Machines, research report, CK-SVT-WP11, CVTS, Pilsen, 2012.
[8] http://www.zcu.cz/research/Grantovy-system/motivacni-system/2013/cast_POSTDOC_2013, (2013), University of West Bohemia, Accessed on: 2013-06-13.
[9] A.I. Burshstein, Introduction to Thermodynamics and Kinetic Theory of Matter, ISBN 9783527618118, 2007.
[10] R.W. Lewis, P. Nithiarasu, Fundamentals of the Finite Element Method for Heat and Fluid Flow, ISBN 9780470014165, 2004.